DISSERTATION ON

EVALUATION OF TEMPORAL BONE IN CHOLESTEATOMA PATIENTS BY HIGH RESOLUTION COMPUTED TOMOGRAPHY

Submitted in partial fulfillment of the requirements for

M.D. DEGREE – BRANCH–VIII - RADIODIAGNOSIS

THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY CHENNAI

MADRAS MEDICAL COLLEGE

CHENNAI-600 003.

MARCH 2007

CERTIFICATE

*This is to certify that dissertation entitled "***EVALUATION OF TEMPORAL BONE IN CHOLESTEATOMA PATIENTS BY HIGH RESOLUTION COMPUTED TOMOGRAPHY"** *submitted by* **Dr.P.CHITRARASAN** *appearing for MD (Branch-VIII) Radiognosis Examination in March 2007 is a bonafide work done by him under my direct guidance and supervision in partial fulfillment of regulation of The Tamilnadu Dr.MGR Medical University, Chennai. I forward this to The Tamilnadu Dr. M.G.R Medical University Chennai, Tamilnadu, India.*

Signature of the Guide
Prof. N. KULASEKARAN, MDRD, DMRD
Professor,
Barnard Institute of Radiology
Madras Medical College
Chennai- 600 003.

Signature of the Director
Prof. T.S. SWAMINATHAN MD,DMRD
Director,
Barnard Institute of Radiology
Madras Medical College
Chennai- 600 003.

Dr. KALAVATHY PONNIRAIVAN M.D.,
Dean
Madras Medical College,
Chennai- 600 003.

DECLARATION

I declare that this dissertation titled **"EVALUATION OF TEMPORAL BONE IN CHOLESTEATOMA PATIENTS BY HIGH RESOLUTION COMPUTED TOMOGRAPHY"** *has been conducted by me under the guidance and supervision of Dr.N.KULASEKARAN, MD, DMRD, Additional Professor Barnard Institute of Radiology, Madras Medical College, Chennai. It is submitted in part of fulfillment of the requirement of award of MD, (Branch-VIII) Radio Diagnosis – March 2007 to be held under The Tamil Nadu Dr.M.G.R. Medical University, Chennai. This has not been submitted previously by me for award of any Diploma or Degree in any other University.*

Dr. P.Chitrarasan
Postgraduate M.D., Radio Diagnosis
Barnard Institute of Radiology,
Madras Medical College,
Chennai- 600 003.

Acknowledgement

I express my sincere gratitude to **Prof. KALAVATHY PONNIRAIVAN, MD.,** DEAN, Madras Medical College for giving me permission to conduct the study in this institution.

With extreme gratefulness, I express my indebt ness to **Prof. T.S.SWAMINATHAN., MDRD., DMRD., FICR., Director,** Barnard Institute of Radiology, for having encouraged me to take up this study. But for his guiding spirit, perseverance and wisdom, this study would not have materialized.

I express my sincere thank and gratitude to **Prof.V.CHANDRASEKHAR, MDRD, DMRD,** Head of the Department, Barnard Institute of Radiology, for his immense kindness, constant support and consistent encouragement in conducting this study.

I wish to thank **Prof. KUPPUSWAMY, MDRD, DMRD, Prof.N.KULASEKARAN, MDRD, DMRD, FICR, Prof. A. P. ANNADURAI, MDRD, DMRD, Prof. K.VANITHA, MDRD, DMRD, DRM** for their support, valuable criticism and encouragement

I am greatly indebted to my Assistant professors **Dr.Umapathy, DMRD, Dr. Sundareswaran, DMRD, Dr. Nesam Manivannan, DMRD, Dr.R.Ravi, MDRD, Dr. Babu Peter, MDRD, DNB, Dr. Ramesh, MDRD** and **Dr. C.Amarnath, MDRD, DNB, FRCR** for their untiring help.

I thank my fellow postgraduate colleagues for their help and cooperation during the study.

I thank all the staff of BARNARD INSTITUTE OF RADIOLOGY for helping me to conduct this study.

I thank my parents and my wife for their support and encouragement.

Finally I thank all my patients for their cooperation without whom this study would not have materialised.

CONTENTS

INTRODUCTION

The human temporal bone is an extremely complex structure that contains the organs of hearing and balance with many other components as major vessels and nerves coursing through it. It is also in direct contact with vital cranial structures that include the brain-stem, cerebellum, temporal lobe etc.

Because of its many important and diverse functions imaging of temporal bone has been of great interest since the earliest development of roentgenography.

A major advantage in diagnostic imaging has occurred with the introduction of High Resolution Computed Tomography and MRI, which have challenged the older modalities and has made it possible to obtain high quality images with exquisite demonstration of most of the normal temporal bone structures and numerous pathological process.

Though MRI has expanded the range of pathology that can be accurately evaluated because of its superb soft tissue delineation, it cannot image bony structures.

HRCT provides excellent detail of bony landmarks with in temporal bone due to inherent contrast, its dense bone being surrounded by air of the tympanic cavity and mastoid air cells. It has also added a whole new dimension to evaluation of the temporal bone by allowing visualization of the soft tissue components within and adjacent to the temporal bone.

Because HRCT can assess this area with unprecedented accuracy, it has allowed better understanding of the etiology, pathology, the disease course, earlier detection of complications and alter treatment modality which has considerably reduced the morbidity and mortality pertaining to lesions in this region.

Infections of middle ear are common and much of temporal bone surgery are done for infections of the ear.

Cholesteatoma is traditionally diagnosed by otoscopic examination and treated by explorative surgery. The need for imaging in an uncomplicated case is contentious. This study assesses the usefulness of a pre-operative high-resolution CT scan in depicting the status of the middle ear structures in the presence of cholesteatoma.

AIM

- To study the effectiveness of preoperative HRCT temporal bone in evaluation of patients with cholesteatoma.
- To correlate pre-operative findings with per-operative findings.
- To provide road map for surgeon in these patients.
- Preemptive detection of complications in these patients.

REVIEW OF LITERATURE

Hassmann-Poznanska E, Goscik E,Skotnicka B. et al, in their study the preoperative CT scans were compared with the operative findings in retrospective analysis of 60 ears operated between 1998-2001. The results show good radio-surgical correlation in cholesteatoma for most middle ear structures except for the integrity of long process of incus. CT scans are an important investigative tool prior to cholesteatoma surgery.

Fuse T, Aoyagi M, Koike Y, Sugai Y. et al, in their study preoperative CT findings of the ossicular chain were compared with operative findings in 26 patients with ossicular defects. Preoperative detection of the complete defect of the malleus head and the body and long process of the incus by high-resolution CT was possible in all cases, while detection of the defect of the manubrium of the malleus and superstructure of the stapes could be made in 33.3 and 60%, respectively.

Zhang X, Chen Y, Liu Q, Han Z, Li X. et al, in their study the surgical findings of 51 ears operated on were retrospectively compared with the CT findings. The radio-surgical agreement was excellent for the

malleus (kappa statistics, k = 0.840) and tegmen (0.788), good for the incus (0.700) and semicircular canals (0.56), but poor for the stapes (0.366) and facial nerve dehiscence (0.310). There is a good radio-surgical correlation in Chronic Otitis Media for most middle ear structures except for the integrity of the facial canal and stapes. The scan alerts the surgeon the potential surgical dangers and complications of disease. High-resolution CT scan should be a routine examination prior to middle ear and mastoid surgery.

hton SE, Robson AK, Anslow P, Milford CA. et al, in their study surgical findings were recorded and correlation with CT appearances evaluated. Twenty patients completed the study. CT altered the management plan in 10 and was considered helpful in a further 6

O'Donoghue GM, Bates GJ, Anslow P, Rothera MP. et al, in their study high resolution computerized tomographic scanning was used in the preoperative evaluation of 50 patients with chronic suppurative ear disease. This form of imaging proved to be highly accurate in depicting the extent of soft tissue within the middle ear cleft and mastoid. With the exception of the long process of the incus and the stapes superstructure, the state of the ossicular chain was correctly predicted in over 90% of cases.

Erosion of the labyrinth was clearly depicted in 4 of the 5 cases in which it occurred. The selective use of this modality in the evaluation of patients with chronic suppurative otitis media is valuable.

Chee NW, Tan TY. et al, in their study the radiosurgical agreement was excellent for the malleus (kappa statistics, k=0.83), stapes (0.94) and semicircular canals (0.8), good for the incus (0.62) and tegmen (0.65), but poor for the facial nerve canal (0.3). There is good to excellent radiosurgical correlation in cholesteatoma for most middle ear structures except for the integrity of the facial canal. High-resolution CT scan is an important investigative tool prior to cholesteatoma surgery.

COMPUTED TOMOGRAPHIC ANATOMY

The inner ear structures of temporal bone are oriented to external landmark of the skull, making it possible to align the section plane to structures that needed to be evaluated. The temporal bone has a high inherent radiation attenuation contrast, having both the most dense bone in the body as well as air-filled spaces.

AXIAL SECTIONS:

Made 30 degrees above the anthropologic baseline.

Position; Supine, neck slightly flexed.

Plane; Intersects external auditory meatus and superior orbital rim Structures best seen;

Facial nerve canal, internal auditory canal, vestibular aqueduct, lateral semicircular canal ,oval and round windows, incudomalleolar and incudostapedial articulations

CORONAL SECTIONS:

Made at 105 degrees to the anthropologic baseline

Position; Prone, neck maximally extended.

Plane; Intersects external auditory meatus and perpendicular to planum sphenoidale and parallel to posterior wall of maxillary sinus Structures best seen;

Ossicles, geniculate ganglion, oval window, jugular fossa, middle ear walls, and roof (tegmen tympani), internal auditory canal, and vestibule

AXIAL SECTIONS CAUDAD TO CEPHALAD

AXIAL HYPOTYMPANIC JUGULAR FORAMEN LEVEL

FIGURE 1

The carotid canal lies just anterior to the jugular fossa forming a snowman - like configuration.

Hypotympanum is adjacent to jugular bulb and carotid canal.

Apex of opening of Eustachian canal extends parallel to carotid canal.

The petro-occipital fissure separates the temporal and occipital bones.

AXIAL INFERIOR TYMPANIC LEVEL

FIGURE 2

The anterior and posterior margins of bony external auditory canal show sharp cortical margins.

The descending facial nerve canal is seen as a well defined circular lucency posterior to external auditory canal.

Carotid canal is seen in the anteromedial course parallel to the semicanal for tensor tympani

The medial funnel shaped cochlear aqueduct is seen as a triangular lucency facing the cerebello pontine angle and may mimic the internal auditory canal. Long process of malleus lies parallel to the tympanic cavity.

AXIAL MID TYMPANIC LEVEL

FIGURE 3

Highly complex, but consistent in all patients.

Normal tympanic membrane not visualized. Long process of malleus lies parallel and anterior to long process of incus.

Apical, second, and basal turns of cochlea are well visualized with the cochlear aqueduct.

AXIAL EPITYMPANIC INTERNAL AUDITORY CANAL LEVEL

FIGURE 4

Computed tomography displays the ice-cream cone configuration of head of malleus and body of incus.

The stapes superstructure may be visualized forming an arch over the oval window.

Internal auditory canal is funnel shaped and must be symmetrical. The sinus tympani and descending facial nerve canal are seen lateral and posterior to the internal auditory canal. Posterior semicircular canal and its ampulla are visualized.

AXIAL SEMICIRCULAR CANAL LEVEL

FIGURE 5

Vestibular aqueduct is seen as a thin hockey stick shaped lucency.

A H shaped air space is seen, the anterior part is formed by epitympanic recess, body by mastoid antrum and posterior part by mastoid air cells.

Tegmen tympani may be visualized as a thin plate of bone.

Medial margin of the antrum is the promontory formed by the otic capsule of the lateral semicircular canal.

CORONAL SECTIONS ANTERIOR TO POSTERIOR

ANTERIOR TYMPANIC LEVEL

FIGURE 6

Superior and inferior walls of external auditory canal are visualized. Tympanic membrane is seen as a thin filamentous structure extending from scutum superiorly to the limbus inferiorly.

Head of malleus is seen in the epitympanic space and the long process of malleus is seen parallel to the tympanic membrane.

The basal and second turn of cochlea and internal auditory canal are seen surrounded by the dense otic capsule

CORONAL MID-TYMPANIC LEVEL

FIGURE 7

L-shaped configuration formed by the body of incus and incudostapedial joint with the stapes projecting medially from the body of incus towards the oval window above the cochlear promontory is visualized.

Proximal limb of geniculate ganglion is seen superior and lateral to the cochlea.

Horizontal portion of VII nerve is seen as a small circular structure beneath the lateral semicircular canal.

CORONAL OVAL WINDOW LEVEL

FIGURE 8

The oval window is seen as a bony defect in the lateral portion of the vestibule.

Full internal auditory canal including the crista falciformis is visualized.

The stapes is seen towards the oval window just inferior to the lateral semicircular canal and horizontal portion of VII nerve.

CORONAL POSTERIOR MIDDLE EAR

FIGURE 9

Sinus tympani extends between the vestibule and pyramidal eminence. The round window is also visualized.

The region of posterior genu of VII nerve is seen.

The styloid process and hypoglossal canal are also visualized.

CORONAL JUGULAR FORAMEN LEVEL

FIGURE 10

Jugular foramen and bulb are seen as a dome shaped structure, the lateral wall of which is lined by mastoid air cells.

The descending part of VII nerve is seen running vertically down inferior to the lateral semicircular canal.

SURGICAL ANATOMY OF MIDDLE EAR IN RELEVANCE TO CHOLESTEATOMA

DEVELOPMENT OF TYMPANIC CAVITY

During 3-7 months of intra uterine life four endothellially lined sacs evaginate from first branchial pouch to form tympanic cavity. Mucosal folds and suspensory ligaments are formed where the sacs contact each other.

SACCUS MEDIUS-

Saccus medius splits into3 saccules

1. MEDIAL- Prussak's space and superior incudal space
2. ANTERIOR- anterior epitympanum
3. POSTERIOR- petrous air cells

SACCUS ANTICUS

1. Anterior portion of middle ear
2. Anterior epitympanum

SACCUS POSTICUS

1. Posterior portion of middle ear
2. Hypotympanum facial recess, sinus tympani, oval window are derived from the sac.

SACCUS SUPERIOR

1. Inferior incudal space
2. Pneumatization of squamous temporal bone

ATTIC OR EPITYMPANUM

Commonest site for cholesteatoma

Pars flaccida lacks regular arrangements of middle fibrous layer, hence more prone for retraction

Ventilation is difficult to maintain after surgery

SUPERIOR - tegmen tympani

MEDIAL - horizontal part of facial

INFERIOR - tympanic diaphragm nerve

ANTERIOR - COG

LATERAL - Paars flaccida & scutum

POSTERIOR - ADITUS

Communicates with mesotympanum through tympanic isthmus

Tympanic anticus- medial to body of incus, between stapes and tensor tympani tendon

Tympanic posticus- lies between medial incudal fold and posterior tympanic wall

EPITYMPANIC SINUS OR ANTERIOR EPITYMPANIC SPACE

Cholesteatoma in epitympanic sinus may not be recognized. It is a cavity of varying size and shape anterior to attic, separated by bony crest coming from tegmen tympani that is cog.

SUPERIOR WALL	- Tegmen tympani
ANTERIOR WALL	- Bony bridge/tegmen tympani
MEDIAL WALL	-Bone covering facial nerve at geniculate ganglion
LATERAL WALL	- tympanic ring
INFERIOR BORDER	- tensor tympani fold

TYPE A

Sinus is deep and totally surrounded by bone.

TYPE B

Bony plate is poorly developed, long tubo tympanic fold.

TYPE C

No well defined boundaries, tubal recess is large.

Intact canal wall procedure provides poor access to epitympanic sinus.

POSTERIOR TYMPANUM

Cholesteatoma is difficult to remove in this area. End aural approach is preferred.

There are four sinuses

1. Facial sinus
2. Lateral tympanic sinus
3. Sinus tympani
4. Posterior tympanic sinus

SUPRA PYRAMIDAL- facial sinus /posterior tympanic sinus

INFRA PYRAMIDAL- lateral tympanic sinus /sinus tympani

LATERAL TO FACIAL NERVE- facial /lateral tympanic sinus

MEDIAL TO FACIAL NERVE- sinus tympani/posterior tympanicus.

FACIAL SINUS

Situated at second genu, superior to pyramid medial to annulus.

Can be approached through facial recess. Facial recess is a triangle formed by medially facial nerve, laterally chorda tympani, above by fossa incudis.

POSTERIOR TYMPANIC SINUS

Lies medial to facial nerve, superior to ponticus and bridge, and above pyramid.

Majority of cholesteatoma follow typical patterns of growth dictated by their site of origin and its related anatomic structures.

Common areas from which cholesteatoma arise

1. Posterior epitympanum.

2. Posterior mesotympanum

3. Anterior epitympanum

Cholesteatomas spread along pathways formed by mucosal folds, ossicular suspensory ligaments and ossicles themselves.

Cholesteatoma spreads through three routes

1. Posterior spread into superior incudal space
2. Inferior spread to posterior pouch of Von troltsch
3. Anterior spread to anterior epitympanum

SINUS TYMPANI

Largest sinus lies inferior to ponticus and extends down to styloid eminence. Inferiorly limited by subiculum. Commonest cause of recurrence is incomplete removal of disease from this hidden area.

PRUSSAK'S SPACE

Small space lying between neck of malleus and pars flacida,

SUPERIOR - Lateral malleolar fold.

INFERIOR - Lateral process of malleus.

MEDIAL - neck of malleus.

LATERAL - pars flaccida

ANTERIOR POUCH OF VON TROLTSCH

Lies between anterior malleolar fold and that portion of tympanic membrane anterior to handle of malleus.

POSTERIOR POUCH OF VON TROLTSCH

Lies between posterior mallelar fold and that portion of tympanic membrane posterior to handle of malleus.

FACIAL NERVE AND CHOLESTEATOMA

Cholesteaoma most frequently involves facial nerve in its horizontal portion and second genu. Horizontal segment is just superior too oval window and fallopian canal in this region is frequently dehiscent.

Second genu lies medial to short process of incus and just below lateral semicircular canal. Dissection in floor of fossa incudis and removal of posterior buttress can cause damage to second genu.

Rarely anterior epitympanic cholesteatoma can involve facial nerve at its first genu.

TYPICAL GROWTH PATTERNS OF CHOLESTEATOMA

Poserior Epitympanic Cholesteatoma

Prussak's space → Floor of Prussak's space

↓

superior incudal space ↓

↓ posterior pouch of Von troltsch

aditus ad antrum ↓

↓

mastoid posterior mesotympanum

POSTERIOR MESOTYMPANIC CHOLESTEATOMA

Posterior mesotympanum (facial recess/sinus tympani)

↓

tympanicus posterior

↓

inferior incudal space

↓

aditus

↓

mastoid

ANTERIOR EPITYMPANIC CHOLESTEATOMA

Anterior epitympanum → supra tubal recess

↓

Anterior pouch of Von troltsch

CLASSIFICATION AND PATHOGENESIS

A cholesteatoma is a collection of keratinizing squamous epithelium in the middle ear cleft associated with bone resorption.

Cholesteatoma may be classified according to presumed etiology into two general categories: congenital and acquired.

Acquired cholesteatomas can be further divided into primary and secondary. Congenital cholesteatomas are thought to arise from embryonal inclusions or rests of epithelial cells. It refers to cholesteatomas present behind an intact tympanic membrane, without continuity to the external ear canal and in the absence of etiological factors such as tympanic membrane perforation and a history of ear infections. They can be further classified according to location within the temporal bone (the petrous pyramid, mastoid and middle ear cleft).

Several pathogenic mechanisms have been produced to explain the development of acquired cholesteatomas. No single process is accepted as the mechanism for the development of all cases. However, in all types the keratinizing squamous epithelium has spread beyond its normal limits.

With primary acquired cholesteatomas, the cause is due to underlying eustachian tube dysfunction resulting in retraction of the pars flaccida. The problem becomes poor aeration of the epitympanic space which draws the pars flaccida medially on top of the malleus neck. Once a retraction pocket develops, the normal migratory pattern of the tympanic membrane epithelium is altered, encouraging the accumulation of keratin.

If not addressed, the sac slowly enlarges to and around the ossicles, the attic walls, etc. The following theories explain secondary acquired cholesteatoma pathogenesis. The implantation theory proposes that squamous epithelium becomes implanted into the middle ear as a result of surgery, foreign body (ventilating tubes), or blast injury. The metaplasia theory explains that as a result of chronic or recurrent otitis media the low cuboidal epithelium of the middle ear becomes transformed to a keratinized stratified squamous epithelium, similar to other parts of the body (nose, sinuses, bronchi) in response to chronic irritation or infection. The mechanism behind the epithelial invasion or migration theory is that whenever there is a permanent perforation of the tympanic membrane, the squamous epithelium starts migrating along the perforation edge and may continue medially along the undersurface of

the drum destroying the columnar epithelium. It has been proposed that this process is triggered by lingering, chronic infection within the tympanic cavity. Papillary in growth refers to the development of cholesteatoma arising from an intact pars flaccida (Shrapnell's membrane). It is theorized that an inflammatory reaction in Prussack's space, likely secondary to poor ventilation in this area, may cause a break in the basal membrane allowing a cord of epithelial cells to start their proliferation inwards.

MANAGEMENT

Cholesteatoma is a surgical disease for which the primary, universally accepted goal is total eradication of cholesteatoma to obtain a safe, dry ear.

The second objective is restoration or maintaining the functional capacity of the ear, the hearing. The third objective is to maintain a normal anatomic appearance of the ear if possible.

Management of complications when they arise takes priority over other objectives. The surgical procedure to be used should be designed for each individual case according to the pathology present.

The extent of disease often will determine the aggressiveness of the surgical approach.

Canal-wall-down (CWD) procedures

Prior to the advent of tympanoplasty techniques, all cholesteatoma surgery was of this type. A classic CWD operation is the modified radical mastoidectomy in which the middle ear space is preserved.

The radical mastoidectomy is a CWD operation in which the middle ear space is eliminated and the eustachian tube plugged.

The indications for this as an initial approach are:

1) cholesteatoma in an only hearing ear
2) significant erosion of the posterior bony canal wall
3) history of vertigo suggesting a labyrinthine fistula
4) recurrent cholesteatoma after ICW surgery with poor eustachian tube function
5) sclerotic mastoid (with limited access to the epitympanum)

Intact-canal-wall (ICW) procedure

This procedure was developed to avoid cavity problems altogether. It consists of preservation of the posterior bony external auditory canal wall.

This approach may be indicated in patients with a large pneumatized mastoid and a well aerated middle ear space, suggesting good Eustachian tube function. Intact canal wall procedures are contraindicated in only hearing ears or in the patient with a labyrinthine fistula, long-standing ear disease, or poor eustachian tube function.

TRANSCANAL ANTERIOR ATTICOTOMY

This procedure is indicated for limited cholesteatoma involving the middle ear, ossicular chain, and epitympanum.

BONDY MODIFIED RADICAL MASTOIDECTOMY

Although rarely used today, this is a useful procedure for specific types of cholesteatoma. It is indicated for attic and mastoid cholesteatoma that does not involve the middle ear space and is lateral to the ossicles.

Complications of cholesteatoma:

Conductive hearing loss is a common complication of cholesteatoma as ossicular chain erosion occurs in as many as 30% of cases.

Erosion of the lenticular process and or stapes superstructure may produce a conductive hearing loss as high as 50dB.

Evidence of sensorineural hearing loss may indicate involvement of the labyrinth.

Labyrinthine fistula may occur in as many as 10% of patients with chronic ear infection due to cholesteatoma. A fistula should be suspected in a patient with longstanding disease with sensorineural hearing loss and or vertigo induced by noise or pressure changes in the middle ear. Absence of a positive fistula test does not rule out this complication. Fine cut CT of the temporal bone should be obtained. The most common site is the horizontal semicircular canal, although the basal turn of the cochlea is also at risk. The procedure of choice with this complication has been the modified radical mastoidectomy, as discussed previously.

Facial paralysis in patients with cholesteatoma requires immediate surgery. The paralysis may develop acutely following infection or slowly from chronic expansion of the cholesteatoma. A CT of the temporal bone is obtained which helps localize the involvement. The most common site is the geniculate ganglion from disease in the anterior epitympanum.

Intracranial complications of cholesteatoma are potentially life-threatening. Infections such as periosteal abscess, lateral sinus thrombosis and intracranial abscess occur in less than 1% of all cholesteatomas.

MATERIALS AND METHODS

A total of 64 patients of whom 35 were males and 29 were females were studied. Age group varied from 5 to 60 years. Patients were selected from out patient's clinic and wards of Otorhinolaryngology, Government General Hospital, Chennai.

Period of study from February 2005 to August 2006

Patients were selected on the basis of their symptoms and clinical findings suggestive of a lesion involving temporal bone such as refractory otorrhoea, otoscopically evident cholesteatoma, retracted tympanic membrane in its posterosuperior part.

INCLUSION CRITERIA

Patients with unsafe ear

1. Otoscopically evident cholesteatoma

2. Marginal tympanic membrane perforation

3. Refractory otorrhoea

4. Posterosuperior retraction of tympanic membrane

EXCLUSION CRITERIA

1. Patients with known complications

2. Patients undergone previous surgery in temporal bone

All the examinations were performed on a Toshiba Asteion spiral CT scanner.

Patients were scanned in two planes, one axial at 30 degree with patient placed supine with head flexed and the scan plane passing through the external auditory canal and superior orbital rim.

Coronal sections were performed with the patient placed prone with neck maximally extended. The scan plane was oriented to intersect the external auditory canal parallel to the posterior margin of the maxillary sinus.

PARAMETERS APPLIED;

- A 512X512 Matrix
- FOV 15to 20 cm
- Slice thickness of 1 mm
- 120Kv , 100 mA exposure
- pitch –1

Magnification factor of 1.7 to 2 used for visualization of both temporal bones.

Magnification factor of 3.5 used for evaluating a single temporal bone in great detail.

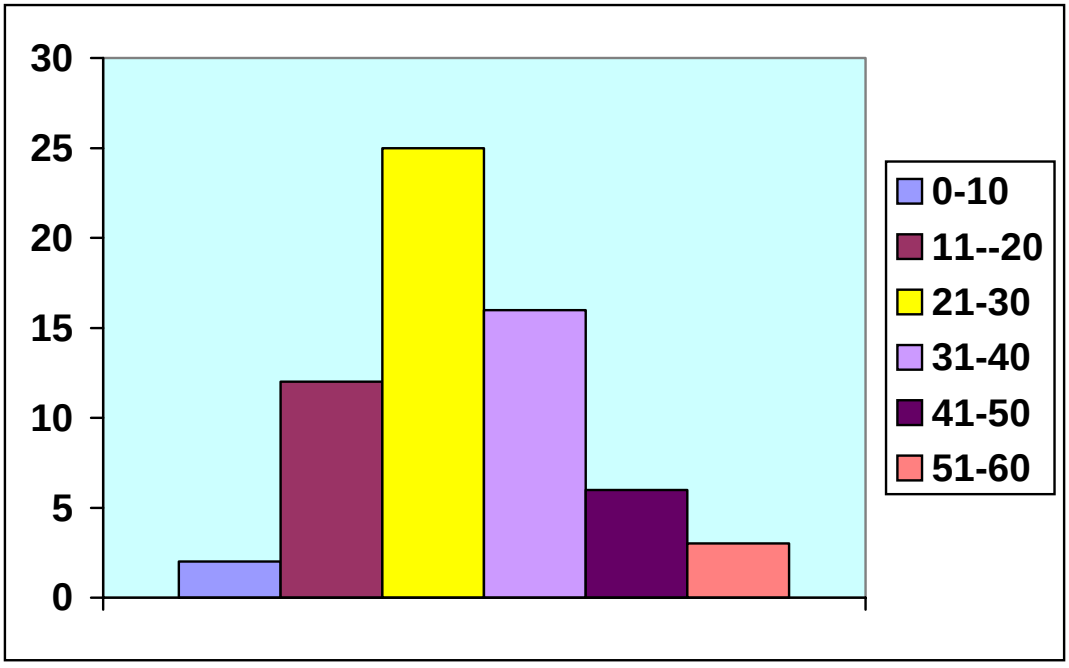
Bone algorithm used for image reconstruction

The features evaluated were

- Erosion and destruction of the lateral attic wall (scutum)
- Widening of aditus ad antrum as the destruction extends into the antrum
- Displacement of the ossicles
- Destruction of the ossicles
- Fistula formation with the lateral and posterior semicircular canals and the vestibule
- Erosion into the facial canal
- Dehiscence of the tegmen tympani
- Destruction of the mastoid (automastoidectomy)
- Dehiscence of the sigmoid plate

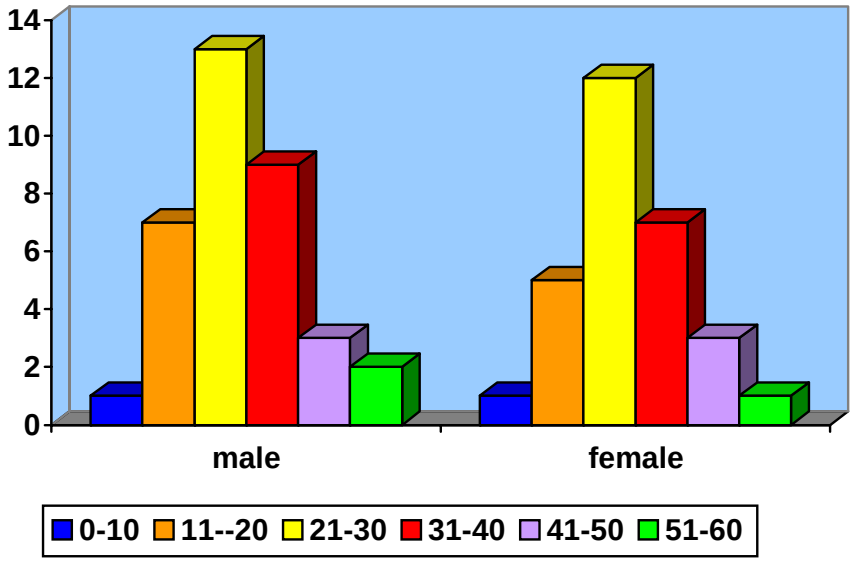
AGE GROUPWISE DISTRIBUTION OF CASES

Age group (years)	*No of cases*	*% of cases*
0 -10	2	3.13
11- 20	12	18.75
21 - 30	25	39.06
31 -40	16	25.00
41- 50	6	9.38
51 - 60	3	4.68



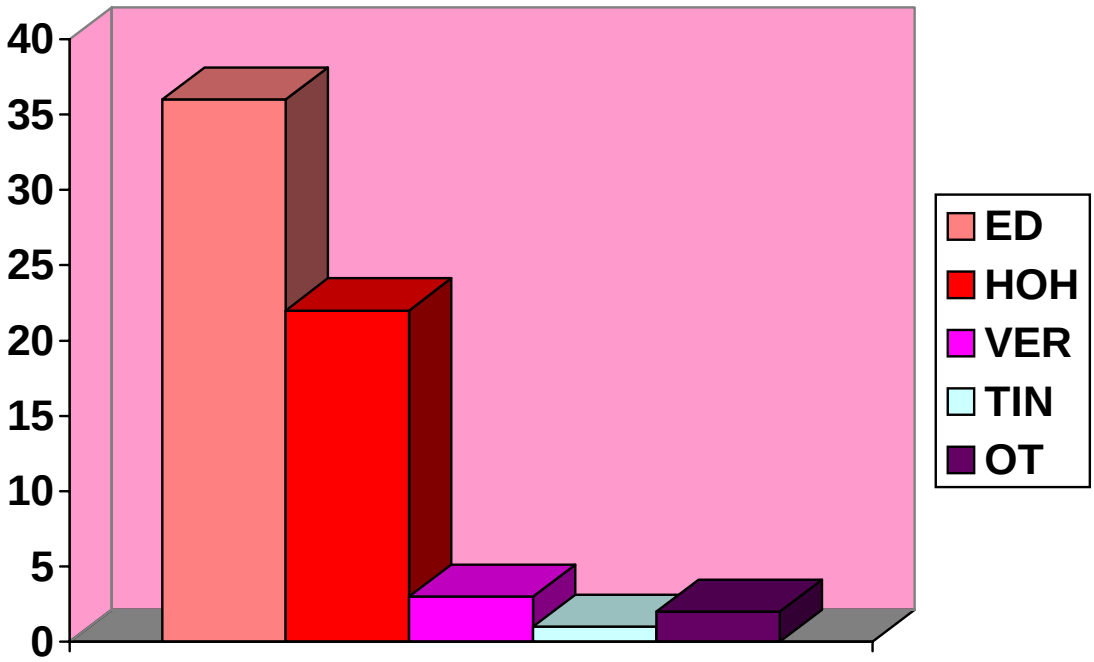
SEXWISE DISTRIBUTION OF CASES

Age group(years)	*Male*	*Female*
0- 10	1	1
11- 20	7	5
21- 30	13	12
31 –40	9	7
41 – 50	3	3
51 – 60	2	1



CLINICAL SYMPTOMS IN DECREASING ORDER OF FREQUENCY

Symptoms	*No of cases*	*% of cases*
Ear discharge	36	56.25
Hard of hearing	22	34.38
Vertigo	03	4.69
Others	02	3.12
Tinnitus	01	1.56



ED-Ear discharge HOH-Hard of hearing

VER-Vertigo TIN-Tinnitus

OT-Others

RESULTS AND ANALYSIS

SOFT TISSUE DENSITY

Acquired cholesteatomas are characterized on CT by the presence of a non-dependent, homogeneous soft tissue mass with a focal area of bone destruction.

In the majority of our cases, this soft tissue density had mass-like features (Figures19,21). The tissue masses were homogeneous in 62 cases (96.87%), non-dependent in 63 (98.44%), and expansile (smooth bony expansion of the attic and mastoid antrum) in 59 (92.20%). The mass subtotally occupied the middle ear cavity and antrum in 52 cases (81.25%).

Only a few (n=7, 11%) of these soft tissue densities had totally filled the whole middle ear cavity, or were focally localized to the attic and mastoid antrum (n=5, 7.81%).

OSSICULAR CHAINS

Erosion of the ossicles is commonly seen with cholesteatomas, as they enlarge and come in contact with contiguous structures in the middle ear. Of the 59 (92.19%) cases with ossicular erosions, the incus was mostly affected (n=48, 75%) (the long process of the incus was the most commonly eroded). The stapes, the second most affected ossicular bone (n=42, 65.62%), was also totally eroded.

Although the malleus was the least affected bone by erosion (n=26,40.64%), its erosions were the most easily observable finding (Figure 13).

In our review, 14 cases (21.87%) showed medial displacement and 2 cases (3%) exhibited lateral shifting (Figure15).

FACIAL NERVE CANALS

HRCT findings are usually straight forward, but in the diseased middle ear the soft tissue densities may abut the tympanic part of the facial nerve canal. To clearly visualize this part of the canal, coronal images must be meticulously analyzed.

Of the 64 cases we found, 12 (18.8%) involvement with 9 (14%) partially eroded (Figure17,18), and 3 (4.69%) were totally destroyed.

SEMICIRCULAR CANALS

Due to its anatomically close proximity to the medial wall of the attic, the lateral semicircular canal is the most frequently eroded.

However, a false impression of the canal fistula may be encountered. Thus, axial CT sections must be reinforced by coronal images for evidence of cortical thinning.

One persistent complication of cholesteatoma is invasion of the labyrinth.

The incidence of labyrinthine fistula secondary to cholesteatoma has remained relatively constant over the last 50 years.

A fistula has been defined as invasion of the bony otic capsule.

By far the most commonly compromised region is the lateral semicircular canal. The diagnosis of fistula can be made when the mass is in direct apposition to the membranous portion of the labyrinth.

Careful evaluation on both axial and coronal images for evidence of cortical thinning in all patients with middle ear disease is necessary.

We have encountered a total of 9 cases (14%) involving the lateral semicircular canals, 4 (6.25%) positive for labyrinthine fistula and 5(7.81%) partially eroded (Figure22,23).

TEGMEN

Overlying the epitympanum and antrum, the tegmen is a thin bony roof that is clearly visualized on coronal sections.

2 (3.13%) were positive for dehiscence (tegmental bone defect) (Figure11). In the remaining 62 (96.8%), the tegmen was intact.

SCUTUM (SPUR)

The bony scutum marks the lateral border of the Prussak's space (between the malleoincudal complex and inferolateral wall of the attic).

Involvement of the scutum was present in 50 cases (78%) in our series.

Forty cases (62.50%) were blunted (Figure13,14) and 10 (15.6%) were destroyed..

ADITUS AD ANTRUM

A superoposterior communication between the attic and the mastoid antrum is called the aditus ad antrum. When **cholesteatoma** is present, it may erode its wall and widen the "waistline" (aditus) resulting in the loss of the "figure of 8".

There were 55 cases (85.9%) of involvement noted, 25 (39.06%) with loss of "figure of 8" and 18 (28.13%) of these had wall erosions (Figure 21).

PETROSQUAMOSAL SEPTUM (KOERNER'S SEPTUM)

The petrosquamosal septum is a pointed bony projection directed obliquely downward and forward, originating from the antral roof.

An antral cholesteatoma usually erodes this thin structure. In our series, there were 57 cases (89%), with 38 (59.38%) partially eroded and 19 (29.68%) completely destroyed. In only 5 cases (7.81%) was the septum preserved.

MASTOID AIR CELLS

Chronic otomastoiditis and tympanic membrane perforation are associated with acquired **cholesteatoma**. In all 64 (100%) cases, the affected mastoids were all sclerotic due to chronic infection. The majority 43 cases (67.18%) are acellular (Figure 16).

MASTOID ANTRUM

In our series, the antra were replaced by soft tissue densities in 55 cases (85.94%), while 48cases (75%) were expanded and 15 cases (23.43%) showed partial smooth bony erosions.

EXTENSIONS

Several spaces may be involved in extensions. In the Eustachian tube, persistence of inflammation in the protympanic mucosa may project downward to the isthmus and lead to eustachian tube dysfunction. This is thought to be a possible pathogenesis of **cholesteatoma**.

In our series, 48 cases (75%) were obstructed. The remaining 16(25%) remained patent and clear. We also hadextensions in thefacial recess in 49 cases (77%), in the tympanic recess (sinus tympani) in 45

cases (70%), in the protympanum in 41 cases (41%), and in the external auditory canal in 14 cases (22%). The measurement of CT density values was found to be of little use because the CT findings were similar in **cholesteatoma**, granulation tissues, and mucosal edema or effusion.

Therefore, they may be indistinguishable on CT scanning, unless an air-fluid level can be seen in the case of middle ear effusion.

EXTENSION BEYOND THE MIDDLE EAR

Complications of cholesteatoma, even in the mildest form, will compromise quality of life and if left unrecognized or untreated may result in death. Complications are related to osseous destruction, which may lead to serious and potentially fatal intracranial conditions. The mechanism of bone destruction by cholesteatoma is explained by the pressure of the matrix of the cholesteatoma and by enzymatic bone resorption.

Two cases were found to have destruction of the tegmen and one case sigmoid sinus plate destruction (Figure24).

AUTOMASTOIDECTOMY

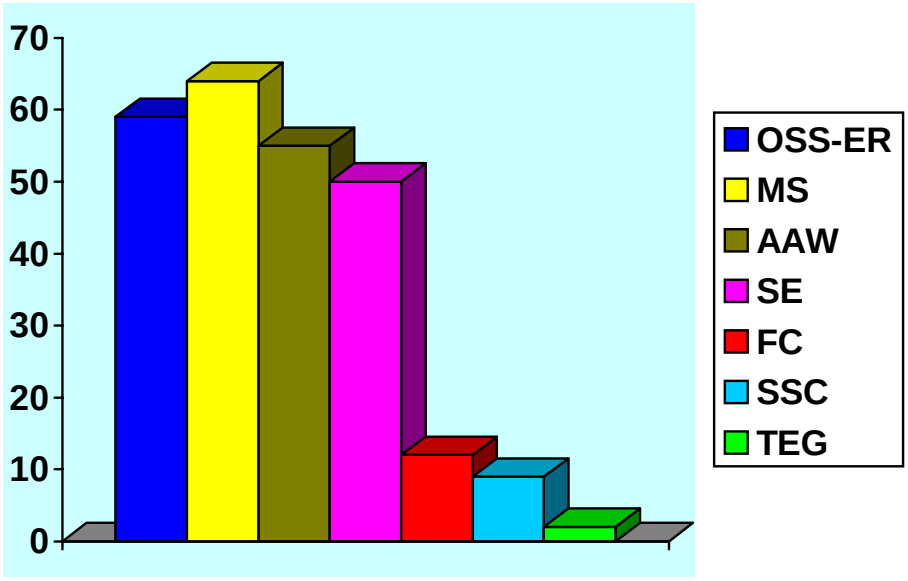
The contents of an acquired cholesteatoma may drain externally, leaving only the aggressive peripheral microscopic membrane that consists of keratinizing stratified squamous epithelium. No soft tissue mass is seen in the imaging and the CT appearance is reminiscent of mastoidectomy.

This is the so-called automastoidectomy (mural **cholesteatoma**).

Only 1 case (1.56%) occurred in our series.

OCCURRENCE OF POSITIVE FINDINGS

CT findings	*No of cases*	*% of cases*
Ossicular erosion	59	92.18
Mastoid sclerosis	64	100.00
Aditus ad antrum widening	55	85.93
Scutum erosion	50	78.12
Facial canal involvement	12	18.75
Semicircular canal fistula	9	14.06
Tegmen erosion	2	3.12



OSS-ER –Ossicular erosion
MS-Mastoid sclerosis
AAW-Aditus ad antrum widening
SE-Scutum erosion
FC-Facial canal involvement
SSC-Semicircular canal fistula
TEG-Tegmen erosion

DISCUSSION

The diagnosis of cholesteatoma is usually made on otologic examination. In cases in which the diagnosis is not obvious, computerized tomography may demonstrate a soft tissue mass with characteristic ossicular displacement and erosion of bone. Cholesteatoma in hidden areas, such as the posterior tympanic recess, may be revealed by a CT scan even if it is not detected by otologic examination. A CT scan also provides information about congenital anatomic variations that may be encountered during surgery, as well as the complications of cholesteatoma.

Years of experience with **HRCT** have clearly demonstrated its superiority for the evaluation of the temporal bone, particularly utilizing the thin- section, high-resolution techniques. **HRCT** provides a more precise definition of the anatomic extent of the disease of the middle ear and the relationship of these cholesteatoma masses to the contiguous structures.

Comparison with the normal is useful in doubtful cases. The hallmarks of cholesteatoma are the presence of soft tissue density in the middle ear cavity, ossicular erosions, smooth erosions of the middle ear borders and adjacent structures. These changes, when associated with bony expansion of the middle ear cavity, are highly suggestive of cholesteatoma. However, they are not specific as other mass lesions like ectopic meningioma may simulate this finding and cannot be differentiated from cholesteatoma.

Our investigation demonstrates that the CT findings that may suggest a diagnosis of middle ear cholesteatoma consist of non-dependent polypoidal soft tissue densification of the middle ear cavity and antrum (focal, partial or total), with associated expansion and smooth erosion of the walls, ossicular displacement and erosions. These features are similar to those described in the literature.

Because they are commonly a complication of chronic mastoiditis, there is almost always co-existing inflammatory disease with adjacent mastoid air cells. Our study demonstrates this in all patients.

When the air cells appear “cloudy” but maintain their irregular trabecular pattern, or whenever there is obliteration of mastoid antrum and periantral cells by increased reactive bone formation, chronic mastoiditis without cholesteatoma is indicated[3].

Complete opacification of the middle ear with no bony destruction makes radiologic differentiation of cholesteatoma from middle ear effusions and granulation tissue difficult, if not impossible.

The presence of an air-fluid level or a soft tissue (fluid) mass in the dependent portion of the middle ear would render support to a diagnosis of effusion.

In cases where the antrum was enlarged with an air-fluid level, this finding was suggestive of infected cholesteatoma[24].

In our series, non-dependent, homogeneous and polypoidal soft tissue densities were present in the mastoid antrum and middle ear cavity. In the majority of cases, soft tissues occupied all spaces at the time of CT study.

Many of the patients had both granulation tissue and cholesteatoma, which could not be radiographically distinguished.

Cholesteatoma in the antrum is characterized by a smooth cavity that is usually larger than normal owing to bone erosion. Because considerable anatomic variations exist in the normal side, it is important to compare the diseased ear with the uninvolved side. Another sign of antral cholesteatoma is erosion or absence of the bony partition known as the Koerner's septum. Out of 64 cases, 57 (89%) in our series demonstrated such involvement.

Signs indicating cholesteatoma in the attic include erosion or destruction of scutum or spur (the lateral wall of the attic) (Figure 13,14), widening of the aditus ad antrum (loss of figure of "8" appearance) (Figure 21), antral wall erosions and widening (Figures21), ossicular erosions and destruction (Figures11,14), medial attic wall erosion which may lead to facial nerve canal involvement, which may cause paresis or paralysis (Figure17,18),erosion of the lateral semicircular canal which may result into fistula formation (Figure22), dehiscence of tegmen tympani (Figure11), dehiscence of sigmoid sinus plate (Figure), erosion of the external auditory canal (EAC), and automastoidectomy.

CT will reliably detect but not always characterize disease. Unfortunately, cholesteatoma sac, associated granulation tissue, mucosal edema and effusion may be indistinguishable on CT scanning.

Although cholesteatoma is said to show a lower attenuation than granulation tissue, the difference is subtle and only magnetic resonance imaging can differentiate the two. After clinical examination, otoscopy and a diagnosis of cholesteatoma, CT can determine its extent by revealing a soft tissue mass and bone erosion, with 80% specificity.

Although otoscopic recognition of cholesteatoma is often reliable, imaging modalities should be used on all patients suspected of harboring a cholesteatoma to determine the presence of gross or subtle changes and the presence of complications, which are mostly due to bone erosions. The specific issues that must be assessed on imaging studies and that will affect the surgical treatment are bone erosion and the degree of extension. CT is sensitive for the detection of early bone erosions and detailed imaging of the soft tissue extent of middle ear cholesteatoma provides information that may affect their surgical resection.

COMPARATIVE ANALYSIS

The analysis of pre-operative **HRCT** scans correlated with the surgical findings with a high degree of accuracy (96.88%) (Table 1). Of 64 cases, evaluation of the malleus was in agreement with the post-operative results in 60 cases (94%). In 4 cases, no erosions were seen in **HRCT** but erosions were found in surgery, but this was due to the long interval between the pre-operative **HRCT** and the day of actual surgical intervention. In the assessment of the incus, 61 cases (96%) matched with the operative findings. Subtle erosions in 3 cases seen in CT images were found to be negative in surgery. The stapes showed agreement in 59 cases (92%) in both pre-operative scans and surgical results. Of the 28 cases (43.75%) with an unclear degree of erosion in **HRCT** scans (due to being masked by the surrounding soft tissue density), the surgical reports indicated total destruction of the stapes in 26 cases (40.63%) while 2 (3.13%) were severely eroded.

The remaining 5 cases (7.81%) showed subtle erosions as analyzed in **HRCT**, but were found normal in surgery. The **HRCT** surgical evaluation of the lateral semicircular canal revealed 63 cases (94.44%) in agreement. In both, partial erosions were seen in 5 cases

(7.81%). There were 4 cases (6.25%)that had labyrinthine fistula in **HRCT** but only 3 (4.69%) were in agreement with the surgical findings. However, the post-operative report stated that the remaining case (1.56%) had marked erosion with dehiscence.

Pre-operative demonstration of facial nerve canal involvement was often difficult not only because of its small size but due to its oblique orientation (tympanic portion) and the presence of developmental dehiscence, particularly when abutted by the soft tissues. The usefulness of the coronal planes is very important in doubtful cases. In our series, 55cases (86%) had CT-surgical agreement. In partially eroded canals, 12 (18.7%) positive cases were shown by CT. Only 7 cases (10.9%) were noted in surgery, 2 (3.13%) of which had dehiscence. The other 5 cases with very subtle marginal irregularities in **HRCT** were negative in surgery. In 3 cases (4.69%) with facial nerve canal destruction, 2 (3.13%) had similar changes in surgery while in 1 (1.56%) more than 50% dehiscence was reported in surgery.

Complete agreement was noted and in one case of automastoidectomy.

The radiosurgical agreement was excellent for malleus (kappa statistics, k=0.811), Stapes(0.817), semicircular canal(0.93), incus (0.867) but good for facial nerve canal (0.633) (Table2) and these results were comparable with N W C Chee T Y Tan and Zhang X, Chen Y, Lin Q , Han z, Li X, study (Table 3)

TABLE NO: 1 – PRE-OPERATIVE CT AND SURGICAL CORRELATION

Diagnosis	***Pre-op CT***	***Surgery***
Cholesteatoma	62	61
Cholesteatoma with Other pathology	2	_
Granulation tissue	_	1
Aural polyp	_	2
Total	64	64

TABLE NO 2:

	Surgical Finding	*Radiological Findings*		*Kappa*
		Intact	*Abnormal*	
Malleus	Intact	32	02	0.811
	Eroded	04	26	
Incus	Intact	13	3	0.867
	Eroded	0	48	
Stapes	Intact	17	5	0.817
	Absent	0	42	
Facial canal	Intact	43	5	0.633
	Dehiscent	4	12	
Labryinth	Intact	54	1	0.938
	Fistula	0	9	

Kappa statistics was used to measure the degree of agreement between surgical and radiological findings. Kappa values exceeding 0.75 represented excellent agreement, values between 0.4 and 0.75 fair to good agreement, and values less than 0.4 poor agreement.

TABLE NO 3: COMPARISON WITH OTHER STUDY (KAPPA)

	N W C CHEE, T Y TAN	ZHANG X CHEN Y LIN Q HAN Z LI X	OUR STUDY
Malleus	0.83	0.84	0.811
Incus	0.62	0.70	0.867
Stapes	0.94	0.366	0.817
Facial canal	0.30	0.310	0.633
Labryinth	0.80	0.56	0.93

On comparison with other studies, our study showed good radio surgical agreement based on Kappa statistics for all the features evaluated.

SUMMARY

In our cases **HRCT** enabled the pre-operative delineation of the cholesteatoma and the recognition of its manifestations and complications.

The proximity of these soft tissue masses to the neighboring structures and facial nerve is best appreciated when the area is viewed in axial and coronal sections using 1x1 mm (**HRCT**).

Excellent contrast between bone, air and soft tissues can be demonstrated.

On imaging of the cholesteatoma, the presences of a soft tissue densification with bone erosions and an expansile effect on the adjacent bony borders of part or all of the middle ear cavity or air cells is considered diagnostic.

In addition, the demonstration of the characteristic appearance of the cavity may be pathgnomonic.

Our study showed excellent correlation between the preoperative **HRCT** scans, and the surgical findings in cholesteatoma cases. **HRCT** is confirmed to be valuable in the diagnosis and in guiding the surgical management of cholesteatoma.

Also, the role of **HRCT** early in the course of the disease can potentially reduces the risks of late complications associated with under diagnosed cholesteatoma.

CT imaging has proven to be an accurate method of depicting the characteristic findings of middle ear **cholesteatoma**, including the extent and complications.

Therefore, **HRCT** is the method of choice for the examination of the middle ear structures and pathology such as **cholesteatoma**.

Our results are consistent with those of previously recognized series and suggest that the diagnosis of middle ear **cholesteatoma** may be indicated by certain characteristic findings in CT.

CONCLUSION

The advent of HRCT scans of the temporal bone has significantly enhanced the pre-operative evaluation of cholesteatoma. This study has shown that CT imaging for cholesteatoma accurately depicts the status of the middle ear structures. The scan delineates the location and extent of the disease, and provides information on anatomical variations and complications. It serves as a road map to assist the surgeon during cholesteatoma surgery. The HRCT scan is a valuable, useful and indispensable investigative tool prior to cholesteatoma surgery.

Advantages of scanning will then include:

1. A visual aid to pre-operative counselling of the patient.

2. Avoidance of unnecessary surgery owing to its high degree of sensitivity/specificity for middle ear disease.

3. A prediction of the anatomy, ease of surgical access and extent of disease, all of which guide surgical approach.

4. Anticipation of complications of chronic suppurative otitis media.

PROFORMA

Patient name :

Age/sex:

Complaints

Otoscopic findings

CT FINDINGS:

PER-OPERATIVE FINDINGS:

BIBLIOGRAPHY

1. Robert Y, Dubrule F, Carcasset S, et al. Petrous bone extension of middle ear acquired cholesteatoma. Acta Radiologica. 1996; 37: 166-170.

2. Phelps PD, Lloyd GAS.The radiology of cholesteatoma. Clin Radiol. 1980;31:501-512.

3. Swartz JD. Cholesteatoma of the middle ear, diagnosis, etiology and complications. Radiol Clin North Am. 1984;

4. Mafee MF, Levin BC, Applebaum EL, Campos CF. Cholesteatoma of the middle ear and mastoid. Otolaryngol Clin North Am**.** 1988;21:265-268.

5. Leighton SEJ, RobsonAK, Anslow P, Milford CA. The role of CT imaging in the management of chronic suppurative otitis media. Clin Otolaryngol. 1993;18:23-29.

6. Jackler RK, Dillon WP, Schindler RA. Computed tomography in suppurative ear disease: a correlation of surgical and radiographic findings. Laryngoscope. 1984;94: 746-752.

7. Liu DPC, Bergeron RT. Contemporary radiologic imaging in the evaluation of middle ear-attic-antral complex cholesteatomas. Otolaryngol Clin North Am. 1989;22:897-909.

8. Ishii K, Takahashi S, Matsumoto K, Kabayashi T et al. Middle ear cholesteatoma extending into the petrous apex:evaluation by CT and MR imaging. Am J Neuroradiol**.** 1991;12:719-724.

9. Valvassori GE, Buckingham RA. Radiology of the temporal bone. In: Valvassori GE, Buckingham RA, Carter BL, et al, eds. Head and Neck Imaging. Stuttgart: Thieme; 1988;1-172.

10. Silver AJ, Janecka I, Wazen J, et al. Complicate dcholesteatomas: CT findings in inner ear complications of middle ear cholesteatomas. Radiology. 1987;164:47-51.

11. Johnson DW, Voorhess RL, Lufkin RB, Hanafee W, Canalis RF. Cholesteatomas of temporal bone: role of computed tomography. Radiology. 1983;148:733.

12. Swartz JD. Inflammatory disease of the temporal bone. In: Som PM, Bergeron RT, eds. Head and Neck Imaging. St. Louis: Mosby; 1991:993-1027.

13. Herzog JA, Smith PG, Kletzker GR, Maxwell KS. Management of labyrinthine fistulae secondary to cholesteatoma. Am J Otology. 1996;17:410-415.

14. McCabe BF. Labyrinthine fistula in chronic mastoiditis. Ann Otol Rhinol Laryngol. 1984;93(suppl 112):138-141.

15. Chao WY, Chang SJ. Ultrastructure of eustachian tube mucosa in chronic otitis media with cholestetaoma. Am J Otolaryngol. 1996;17:161-166.

16. Bluestone CD, Casselbrant ML, Cantekin EI. Functional obstruction of the eustachian tube in the pathogenesis of aural cholesteatoma in children. In: Spade J, ed. Cholesteatoma and mastoid surgery. Amsterdam: Kugler Publications; 1982:211-224.

17. Chao WY. Eustachian tube dysfunction in the pathogenesis of middle ear cholesteatoma: clinical considerations. In: HsienT, ed. Proceedings of the second sino Japanese Otolaryngology-Head and Neck Surgery Academic Conference. Taipei, Taiwan; 1993:42-43

18. Watts S, Flood LM, Clifford KA. Systematic approach to interpretation of computed tomography scans prior to surgery of middle ear cholesteatoma. J Laryngol Otology. 2000;114:248-253.

19. Phelps PD, Wright A. Imaging cholesteatoma. Clin Radiol. 1990;41:156-162.

20. Jackler RK, Dillon WP, Schindler RA. Computerised tomography in suppurative ear disease: a correlation of surgical and radiographic findings. Laryngoscope.1984;94:746-752.

21. Harris JP, Darrow DH. Complications of chronic otitis media. In: Nado JB Jr, Shuknet HF, eds. Surgery of the ear and temporal bone**.** New York: Raven Press Ltd;1993:171-190.

22. Chao YH, Yun SH, Shin JO, Yoon JY, Lee DM. Cochlear fistula in chronic otitis media with cholesteatoma. The Am J Otology. 1996;17:15-18.

23. Abramson M, Harke LA, McCabe BF. Labyrinthine fistula complicating chronic suppurative otitis media. Arch Otolaryngol. 1974;100:141-142.

24. Buckingham RA,Valvassori GE. Tomographic evaluation of cholesteatoma of the middle ear and mastoid. Otolaryngol Clin North Am. 1973;6:363-377.

25. Buckingham RA, Valvassori GE. Tomographic and surgical pathology of cholesteatoma. Arch Otolaryngol. 1970;91:464-496.

26. Mafee MF, Kumar A, Yannias D, et al. Computed tomography of the middle ear in the evaluation of cholesteatoma and other soft tissue masses: comparison with pleuri-direction tomography. Radiology. 1983;148: 465-472.

27. Swartz JD, Goodman RS, Russel KB. High resolution computed tomography of the middle ear and mastoid. Part II: Tubotympanic disease. Radiology. 1983; 148:455-459.

MASTER CHART

S.NO	PT NAME	AGE	SEX	C/O	OTO	CT FINDINGS													
						SE	AAW	OSS-DIS		OSS-DES			FISTULA			FCE	TTD	MS	SD
								ML	LL	M	I	S	LS	PS	SS				
1.	**RAVI**	**12**	**1**	**ED**	**CH**	+	+	_	_	+	+	+	+	_	_	+	_	+	_
2.	**GURU**	**18**	**1**	**ED**	**CH**	+	+	_	_	+	+	_	_	_	_	_	_	+	_
3.	**SHANKAR**	**8**	**2**	**ED**	**PTM**	_	+	_	_	_	+	_	_	_	_	_	_	+	_
4.	**ARJUN**	**20**	**1**	**ED**	**CH**	+	_	+	_	_		+	_	_	_	_	_	+	_
5.	**KALA**	**32**	**2**	**HOH**	**CH**	+	+	_	_	+	+	+	+	_	_	+	_	+	_
6.	**SANTI**	**6**	**2**	**ED**	**CH**	_	+	+	_	_	+	_	_	_	_	_	_	+	_
7.	**KUMAR**	**44**	**1**	**ED**	**CH**	+	+	_	_	+	_	_	_	_	_	_	_	+	_
8.	**DOSS**	**55**	**1**	**HOH**	**CH**	_	_	+	_	_	_	+	_	_	_	_	_	+	_
9.	**JOHN**	**28**	**1**	**HOH**	**CH**	+	+	_	_	+	_	_	_	_	_	_	_	+	_
10.	**JANAKI**	**24**	**2**	**ED**	**CH**	+	+	+	_	_	_	+	_	_	_	_	_	+	_
11.	**VEL**	**14**	**1**	**HOH**	**CH**	+	+	_	_	+	+	+	_	_	_	_	_	+	_
12.	**GUNA**	**22**	**2**	**HOH**	**CH**	+	+	+	_	_	_	+	_	_	_	_	_	+	_

S.NO	PT NAME	AGE	SEX	C/O	OTO	CT FINDINGS													
						SE	AAW	OSS-DIS		OSS-DES			FISTULA			FCE	TTD	MS	SD
								ML	LL	M	I	S	LS	PS	SS				
13.	**MALATHY**	**29**	**2**	**ED**	**CH**	_	+	_	_	+	+	+	+	_	_	+	_	+	_
14.	**VENKAT**	**38**	**1**	**ED**	**CH**	+	+	_	+	_	+	+	_	_	_	_	_	+	_
15.	**RAJ**	**33**	**1**	**ED**	**CH**	_	+	_	_	+	+	+	+	_	_	+	_	+	_
16.	**INBAN**	**48**	**1**	**TIN**	**CH**	+	_	_	_	_	_		_	_	_	_	_	+	_
17.	**HARI**	**52**	**1**	**ED**	**CH**	+	+	_	_	+	+	+	_	_	_	_	_	+	_
18.	**SETU**	**54**	**1**	**HOH**	**CH**	_	+	+	_	_	+		_	_	_	_	_	+	_
19.	**UMA**	**44**	**2**	**ED**	**CH**	+	+	_	_	+	_	+	_	_	_	+	_	+	_
20.	**USHA**	**42**	**2**	**HOH**	**CH**	_	+	_	_	_	+	+	_	_	_	_	_	+	_
21.	**VALLI**	**32**	**2**	**ED**	**CH**	+	+	_	_	+	+	+	_	_	_	+	_	+	_
22.	**GURU**	**24**	**1**	**HOH**	**CH**	+	+	+	_	_	+	_	_	_	_	_	_	+	_
23.	**KAMALA**	**36**	**2**	**ED**	**CH**	+	+	_	+	_	_	+	_	_	_	_	_	+	_
24.	**DEVI**	**35**	**2**	**VER**	**PTM**	+	_	+	_	_	_	+	+	_	_	_	_	+	_
25.	**RAM**	**22**	**1**	**HOH**	**CH**	+	+	_	_	+	+	+	_	_	_	+	+	+	+
26.	**CHEZIAN**	**27**	**1**	**ED**	**CH**	+	+	+	_	_	+	+	_	_	_	_	_	+	_

S.NO	PT NAME	AGE	SEX	C/O	OTO	CT FINDINGS													
						SE	AAW	OSS-DIS		OSS-DES			FISTULA			FCE	TTD	MS	SD
								ML	LL	M	I	S	LS	PS	SS				
27.	**NELLAI**	**23**	**1**	**ED**	**CH**	+	+	_	+	_	+	_	_	_	_	_	_	+	_
28.	**DIVYA**	**15**	**2**	**ED**	**RTM**	+	+	_	_	_	+	+	_	_	_	_	_	+	_
29.	**MANIKAM**	**18**	**1**	**HOH**	**CH**	_	+	_	_	+	_	_	_	_	_	_	_	+	_
30.	**KALKI**	**22**	**2**	**ED**	**CH**	+	+	+	_	_	+	+	_	_	_	_	_	+	_
31.	**BHUVAN**	**44**	**2**	**ED**	**CH**	+	+	_	_	+	+	+	_	_	_	_	+	+	_
32.	**GOWTAM**	**47**	**1**	**ED**	**CH**	+	+	_	_	_	+	+	_	_	_	_	_	+	_
33.	**SURYA**	**36**	**1**	**HOH**	**CH**	_	+	_	+	_	+	_	_	_	_	_	_	+	_
34.	**MAHESH**	**38**	**1**	**HOH**	**CH**	+	+	_	_	_	+	+	_	_	_	_	_	+	_
35.	**PRIYA**	**28**	**2**	**VER**	**CH**	+	+	_	_	+	+	+	+	_	_	+	_	+	_
36.	**SNEHA**	**25**	**2**	**HOH**	**RTM**	+	_	_	_	_	+	_	_	_	_	_	_	+	_
37.	**RAMESH**	**29**	**1**	**ED**	**CH**	+	+	+	_	_		+	_	_	_	_	_	+	_
38.	**MADAN**	**34**	**1**	**ED**	**CH**	+	+	_	_	+	+	+	_	_	_	+	_	+	_
39.	**SENTHIL**	**37**	**1**	**ED**	**PTM**	+	+	_	_	+	+	+	_	_	_	_	_	+	_
40.	**VENU**	**38**	**1**	**VER**	**CH**	+	+	_	+	_	+	_	+	_	_	_	_	+	_

S.NO	PT NAME	AGE	SEX	C/O	OTO	CT FINDINGS													
						SE	AAW	OSS-DIS		OSS-DES			FISTULA			FCE	TTD	MS	SD
								ML	LL	M	I	S	LS	PS	SS				
41.	**SUBRAMANI**	**18**	**1**	**ED**	**CH**	+	+	_	_	+	+	_	_	_	_	_	_	+	_
42.	**KUMAR**	**38**	**1**	**ED**	**CH**	+	+	_	_	+	+	+	_	_	_	_	_	+	_
43.	**PANDIAN**	**22**	**1**	**HOH**	**CH**	+	+	+	_	_	+	+	_	_	_	_	_	+	_
44.	**ROJA**	**15**	**2**	**ED**	**CH**	+	+	_	_	+	+	+	+	_	_	+	_	+	_
45.	**KUMARESAN**	**18**	**1**	**HOH**	**CH**	_	+	_	+	_	+	_	_	_	_	_	_	+	_
46.	**ESWAR**	**35**	**2**	**ED**	**PTM**	+	+	_	_	_	+	+	_	_	_	_	_	+	_
47.	**TODA**	**27**	**1**	**O**	**CH**	+	+	_	_	+	+	+	+	_	_	+	_	+	_
48.	**MURUGU**	**29**	**1**	**HOH**	**CH**	+	+	_	_	_	+	+	_	_	_	_	_	+	_
49.	**KAMALA**	**30**	**2**	**ED**	**CH**	+	+	_	_	+	+	+	_	_	_	_	_	+	_
50.	**MEENA**	**32**	**2**	**ED**	**CH**	+	+	+	_	_	_	_	_	+	+	_	_	+	_
51.	**FAROOQ**	**18**	**1**	**ED**	**CH**	+	+	_	_	+	+	+	_	_	_	_	_	+	_
52.	**SELVI**	**16**	**2**	**ED**	**RTM**	+	_	_	_	_	_	_	_	_	_	_	_	+	_
53.	**SENTIL**	**28**	**1**	**HOH**	**CH**	+	+	_	_	+	+	+	_	_	_	_	_	+	_
54.	**BOSE**	**25**	**1**	**ED**	**CH**	+	+	_	+	_	+	+	_	_	_	_	_	+	_

S.NO	PT NAME	AGE	SEX	C/O	OTO	CT FINDINGS													
						SE	AAW	OSS-DIS		OSS-DES			FISTULA			FCE	TTD	MS	SD
								ML	LL	M	I	S	LS	PS	SS				
55.	**MARY**	**23**	**2**	**O**	**PTM**	+	+	_	_	+	+	_	_	_	_	_	_	+	_
56.	**DANAM**	**29**	**2**	**ED**	**CH**	+	+	+	_	_	+	+	_	_	_	_	_	+	_
57.	**SATYA**	**26**	**2**	**HOH**	**CH**	_	_	_	_	_	_	_	_	_	_	_	_	+	_
58.	**SURYA**	**37**	**2**	**ED**	**CH**	+	+	_	_	+	+	+	_	_	_	+	_	+	_
59.	**RAJA**	**33**	**1**	**ED**	**CH**	+	+	_	+	_	+	+	_	_	_	_	_	+	_
60.	**LEELA**	**27**	**2**	**HOH**	**PTM**	+	+	_	_	_	+		_	_	_	_	_	+	_
61.	**VIJI**	**36**	**2**	**HOH**	**CH**	+	+	_	_	_	+	+	_	_	_	_	_	+	_
62.	**POWN**	**28**	**2**	**ED**	**PTM**	+	+	_	+	_	+	_	_	_	_	_	_	+	_
63.	**MARAN**	**26**	**1**	**HOH**	**RTM**	_	_	_	_	_	_	_	_	_	_	_	_	+	_
64.	**MALA**	**14**	**2**	**HOH**	**CH**	+	+	_	_	_	+	+	_	_	_	_	_	+	_

KEY TO MASTER CHART

SEX –1→Male , 2 →Female
LS –Lateral semicircular canal

SE – Scutum erosion

C/o -- Complaints

ED – Ear discharge

HOH – Hard of hearing

TIN – Tinitus

VER – Vertigo

O -- Others

OTO – Otoscopic finding

CH –Cholesteatoma

RTM –Retracted tympanic membrane

PTM –Perforated tympanic membrane

PS–Posterior semicircular canal

AAW – Aditus ad antrum widening

SS –Superior semicircular canal

OSS-DIS –Ossicular displacement

FCE - Facial canal erosion

ML --Medial

TTD- Tegmen tympani erosion

LL --Lateral

MS - Mastoid sclerosis

OSS-DES –Ossicular destruction

SD-Sigmoid plate dehiscence

M-Maleus

I-Incus

“+” → Present

S-Stapes

“_” → Absent